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Conifer Pests in New Mexico

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Introduction

This guide is intended to help homeowners and forest managers in identifying and controlling forest and ornamental tree pests. The guide focuses on insect and disease pests, but also discusses natural and human-caused environmental problems.

Many pest problems can be prevented by keeping trees healthy and vigorous. Tree pests are usually attracted to and do more damage to stressed, weakened trees. In forests, environmental stresses can sometimes be alleviated by thinning stands to reduce competition among trees. In urban landscapes, trees are often planted in areas where they would not grow naturally; and, thus, may suffer from too much or too little moisture, soil compaction, alkalinity, air pollution, and exposure to sun and wind. In urban areas throughout New Mexico, conifers need supplemental water during the windy spring and at other dry times during the year.

Transplanting wild-grown conifers to urban areas poses other problems. Conifers growing in New Mexico's dry soils have extensive root systems. Generally, few of the roots remain intact when the trees are dug so many transplanted trees die. The larger the tree chosen to transplant, the less likely it will survive. Younger trees are more vigorous, have smaller root systems, are easier to dig, and will quickly grow to a size equal to that of larger, more costly transplants. You can double the survival rate by pruning roots 12 months or more before digging. Cut them with a narrow pointed shovel from 1 to 3 feet out from the tree to a depth of 12 to 18 inches. Prune roots in November, December, or January while the tree is dormant. Conifers must be moved with a ball of soil held firmly intact around the roots. Use tightly wrapped burlap to keep the soil from crumbling during transportation and handling. It 's important to remove burlap, chicken wire, or any other material used to wrap the root ball when resetting the plant in the ground. These materials often don't rust or rot away in dry Southwestern soils and the trees will remain root bound. Please note that white pine wildlings from Southern New Mexico should not be transplanted elsewhere to prevent the spread of white pine blister rust.

The following pages include descriptions of pests, pictures of damage, and pictures of the damage-causing organism wherever possible. Options for mechanical and biological control are provided where such alternatives are effective. At the end of this publication is a list of recommendations for specific pesticide control. Remember that pesticide recommendations are subject to frequent changes in registration and pesticide use regulations. For current recommended controls, contact your county agriculture extension agent or the Cooperative Extension Service at New Mexico State University. Other contacts include the New Mexico Energy, Minerals, and Natural Resource Department's Forestry and Resources Conservation Division in Santa Fe, New Mexico; New Mexico

Department of Agriculture, Las Cruces, New Mexico; or USDA Forest Service, Southwestern Region, Forest Health, Albuquerque, New Mexico.

State law prohibits removing any plant within 300 feet of a public thoroughfare. The law also requires that before removing any plants, you first obtain a written permit from the landowner or land manager. If you plan to dig or sell plants, first apply for a Collected Plant Inspection Certificate and/or a Dealers License from the New Mexico Department of Agriculture.

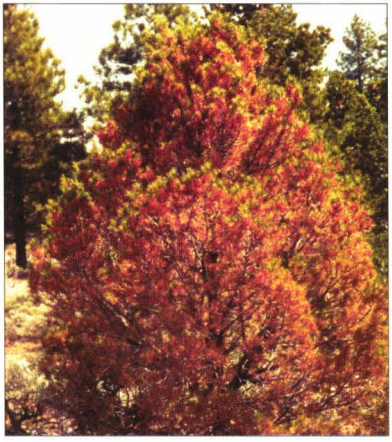
Pinyon Needle Scale

Matsucoccus acalyptus (Herbert)

Pinyon needle scales are small, black, bean-shaped bumps on the surface of 1-year-old piñon needles. These tiny, sap-sucking insects kill the needles and seriously weaken pinyon pines in forests and urban settings. Reduced new growth and stunted needles are common on trees suffering repeated attacks. Heavy infestations frequently kill small trees and predispose weakened larger trees to attack by other insects, especially bark beetles, which can kill trees.

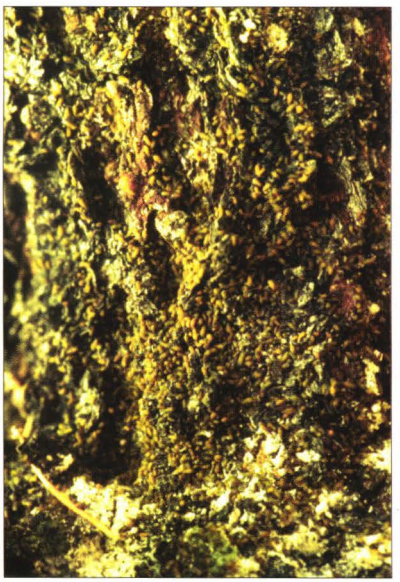
Scales infesting 1-year-old needles.

BIOLOGY: Adult, wingless females emerge from scale coverings in late winter or early spring and mate with winged males. Emergence time in Southern New Mexico communities is mid to late February; in Albuquerque it is early to mid-March; and in Santa Fe and Los Alamos it is mid-March to early April. Most males emerged the previous fall and spent the winter as prepupae in silk webs in litter beneath the tree. A few males don't enter the prepupal stage until early spring. Mated females lay yellow eggs in clusters held together by white, cottony webbing around the root collar, on undersides of large branches, in branch crotches, or in cracks of rough bark. Occasionally, egg masses are found several feet from the base of the tree on a rock or log. About 4 weeks after eggs are laid, tiny, red eye spots can be seen in the eggs with the aid of a hand lens. Nymphs, called crawlers, emerge about 7 to 10 days after eye spots appear. They climb to the ends of branches and settle on the previous year's new growth. After inserting tubelike mouth parts into the needle, they become immobile, cover the body with wax, and turn black.

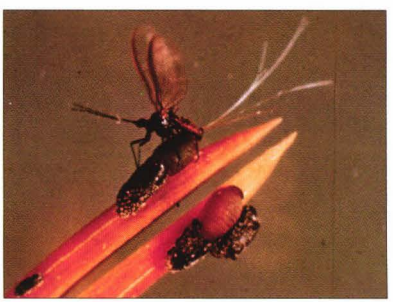


Heavily infested piñon. Only the new growth remains green.

CONTROL: Potential damage from these pests can be drastically reduced by destroying eggs before they hatch. Dislodge egg masses from the tree with a strong stream of water from a garden hose. After washing down the tree, rake up all the material around the base of the tree and destroy or remove it. Chemical insecticides are registered to control the pinyon needle scale, but timing of the spray application is critical for success. Apply insecticides to the bark and branch crotches as soon as crawlers begin to emerge. Examine eggs with a hand lens and be ready to spray shortly after the crawler's red eye spots are visible. Once scales have established themselves on the needles, they become more difficult to control. Additional direct control information is provided on page 50.



Female scales migrating to egg-laying sites in the cracks of rough bark.



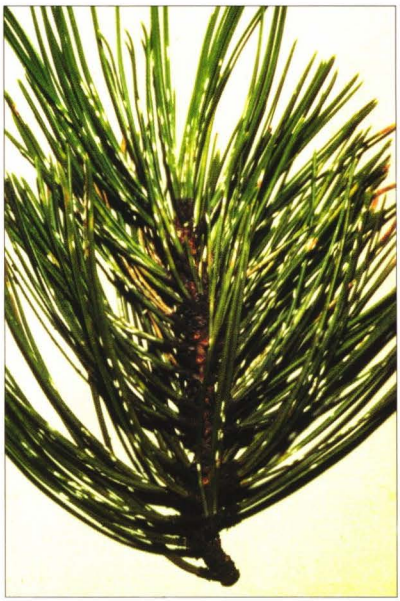
Female scale emerging from scale covering and being mated by winged male.

Cottony webbing and eggs laid at the base of the tree trunk.

Pine Needle Scale

Chionaspis pinifoliae (Fitch)

Pine needle scale is a common pest of most pine species, spruce, and Douglas-fir. Damage is especially noticeable on ornamental pine and spruce trees growing along dusty roads. Insects feed by sucking sap from needles, causing the needles to yellow and eventually drop. Heavy infestations over several years can kill young trees and severely weaken larger trees, predisposing them to attack by other pests.



Pine needle scale on ponderosa pine needles.

BIOLOGY: The pine needle scale has two generations per year. The 1/8-inch-long mature female scales are most conspicuous. They are almost pure white, slender at the front end, and wider at the rear end. Males are smaller, more slender, and rarely seen. Twenty to 30 eggs are laid in the fall and winter beneath the dead female scale. Eggs hatch in May and the nymphs or "crawlers" move to the new green needles to feed. Nymphs mature by early July, adults mate, and new clusters of eggs are laid. Scales of this second generation mature by fall and lay the overwintering eggs.

Enlarged view of female scale on a single needle.

CONTROL: Inspect trees for scales before digging or purchasing for transplant. On established trees, apply a foliar systemic insecticide (see page 50) in May and early June to provide some control of heavy infestations. Insecticides should be applied just before eggs hatch and then once or twice more at 7- to 10-day intervals to control nymphs hatching later. Adult insects are protected by a waxy covering and are almost impossible to kill with contact insecticides. Summer or horticultural oils may improve effectiveness but they can discolor or burn plants if not applied correctly. Cutting or burning small infested trees is the only effective cultural control alternative to chemical insecticides. Ladybird beetles and a few species of parasitic wasps usually keep populations of this pest below seriously damaging levels.

Pinyon Spindle Gall Midge

Pinyonia edulicola Gagne'

Pinyon spindle gall midge produces a spindle-shaped swelling from the needle base that is about 1/2-inch long. The insect is a common forest pest that rarely causes serious damage. However, in urban settings heavy infestations can cause serious defoliation as galls dry and needles drop prematurely.

CONTROL: Controlling this pest usually isn't necessary. Landscape trees under stress that develop heavy infestations, may require treatment with a registered systemic insecticide (see page 50). Apply the insecticide when eggs are laid and hatching starts in late June and early July.

BIOLOGY: The pinyon spindle gall midge is a tiny fly about one-sixteenth of an inch (3-4 mm) long. Adults lay eggs on needles in late June and early July. Larvae hatch soon afterward and mine into the current year's needles, causing galls to form. Each gall contains from 5 to 40 small, orange, legless maggots. Larvae overwinter in the galls and pupate in the spring.

Tiny, orange maggots inside gall.

Needle gall.

Needle Miners

Pinyon Needle Miner

Coleotechnites edulicola Hodges and Stevens

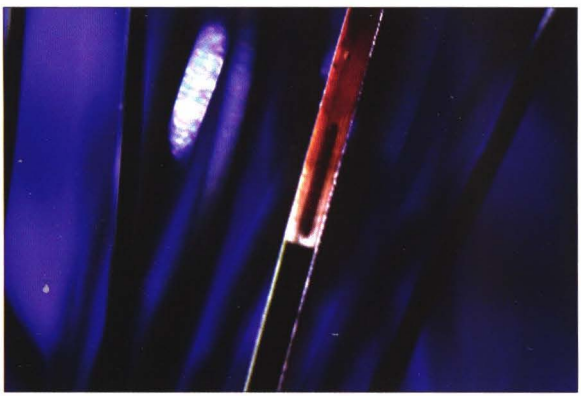
Ponderosa Pine Needle Miner

Coleotechnites ponderosae Hodges and Stevens

Needle miners are locally common on pinyon and ponderosa pine. Species resemble one another in appearance and damage but have different life cycles. Damage first becomes evident as foliage browns. Closer examination reveals hollowed-out needles. Early needle drop, reduced growth, and tree mortality can all result from needle miner infestations. The severity of the infestation varies significantly from tree to tree, suggesting that individual trees have some resistance to these pests.

BIOLOGY: Pinyon needle miners lay eggs from early June through mid-July. Larvae emerge soon after eggs are laid and bore into uninfested needles where they feed until fall. They overwinter inside the needles as dormant larvae. Feeding resumes in the spring and larvae grow to about three-eighths of an inch (5 mm) long. Pupation occurs in late May.

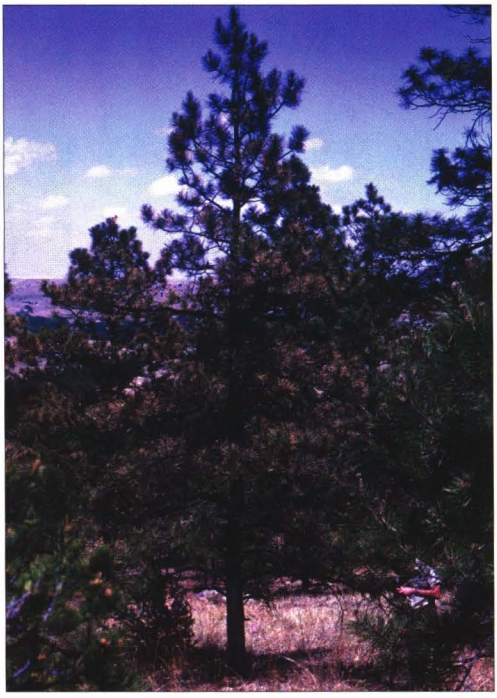
Pinyon needle miner exit hole.



Ponderosa pine needle miner inside needle.

Ponderosa pine needle miners lay eggs in late summer inside previously mined needles. The newly hatched larva bores into the tip of a green needle and mines slowly through the winter, developing more rapidly as the weather warms and then pupating in mid-summer.

CONTROL: Trees usually recover from needle miner damage without suffering serious injury. For direct control, use a foliar systemic insecticide after eggs have hatched (see page 50).



Ponderosa needle miner damage.

Pinyon needle miner damage.

Tiger Moth

Lophocampa (Halisidota) spp.

Tiger moths are most often encountered on ponderosa and piñon pines and occasionally on juniper and Douglas-fir. Natural enemies generally prevent them from becoming a serious forest pest. Webbing and branch defoliation caused by tiger moths is unsightly on ornamentals.

BIOLOGY: Tiger moths produce one generation per year. Adult moths emerge from mid-July to late August. Females lay clusters of light green eggs on needles and twigs of host trees. Eggs hatch in 3 to 6 weeks. The small gregarious larvae are dark brown to black and quite hairy. Groups of young feed on current needles and form webs or tents enclosing a portion of the branch. Feeding continues through the fall and larvae overwinter in tents. Tents are usually located in the topmost branches or on the trees' south and west sides. Larvae will feed outside the webbing on warm sunny days throughout winter, returning to the tent before nightfall. By early spring, tents are large, conspicuous, and filled with masses of dead needles.

Tiger moth tent.

As caterpillars reach their full growth, they feed alone away from the tent, often migrating to another tree. Full-grown caterpillars are about 1-1/2 (3.5-4 cm) inches long and covered with yellow-brown to dark brown hairs that can cause a skin rash on people sensitive to them. In June, mature caterpillars spin brownish cocoons of silk and body hairs. These cocoons are attached to branches, limbs, and trunks of the host trees and occasionally to debris on the ground.

Tiger moth caterpillars.

CONTROL: Chemical insecticides and the bacterial insecticide, *B. t. (Bacillus thuringiensis)*, are available but not usually necessary. Remove tiger moth infestations by simply pruning and destroying branches with tents while larvae are resting inside.

Douglas-fir Tussock Moth

Orgyia pseudotsugata (McDunnough)

The Douglas-fir tussock moth is one of the most destructive pests on ornamental Douglas-fir, white fir, and blue spruce in New Mexico. Needles in the upper portion of infested trees may be completely removed after 1 or 2 years of feeding. In Southwestern forests, tussock moth outbreaks have generally been confined to overmature, multi-storied stands of white fir and Douglas-fir.

Defoliation by Douglas-fir tussock moth often kills the top of the tree.

BIOLOGY: Eggs hatch from mid-May to early June and caterpillars feed on the current year's developing foliage. Young larvae are 1/8 to 1/4 inch (4-7 mm) long and covered with long, thin body hairs that later develop into tufts. Because the female moth is wingless, the primary means of dispersal from tree to tree is by windblown larvae. Young larvae congregate on the tops of defoliated trees and drop on silken threads that may be over 10 feet long. These threads eventually break from the tree and give a ballooning effect to the larvae. If caught by a strong wind, some larvae may be blown great distances. Many of the larvae will never find a suitable host and perish during dispersal.

Mature larva.

Mature larvae are up to 1-1/4 inches (31 mm) long and very colorful. Behind the head are two long, dark tufts of hair that resemble horns projecting forward. On the posterior is a longer tuft of hair projecting backward. In the middle of the back are four dense, buff-colored tussocks. Short hairs radiating from red, buttonlike centers cover the rest of the body except for the head and legs. Some people develop an itchy rash from exposure to the frequently airborne caterpillar hairs.

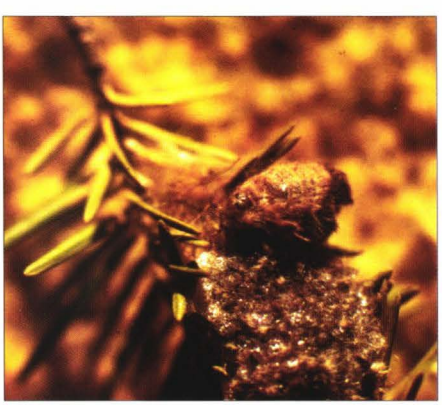
Older caterpillars do the most damage. After they are about half grown, they feed on new and older foliage lower in the crown and farther back on the branches.

Cocoon on underside of branch.

Pupation occurs inside a thin, silk cocoon spun on the undersides of branches from late July to the end of August. Adults emerge within 10 to 18 days, depending on temperature.

The female moth has only rudimentary wings and cannot fly. She emits a chemical sex attractant and soon mates. If undisturbed, all of her eggs will be deposited in a single mass on top of the cocoon from which she emerged. From 150 to 300 eggs are laid in a dry, tough, frothy substance covered with hairs from the female's body. Overwintering occurs in the egg stage.

CONTROL: Without some form of control, trees can be completely stripped of all needles and deformed or killed. Both chemical and biological insecticides are registered for use against the Douglas-fir tussock moth. The microbial insecticide, *B.t. (Bacillus thuringiensis)*, can provide an effective alternative to chemical control although results have been variable. Early treatment and multiple sprays improve results. *B.t.* is a bacterium that produces a toxin lethal to many kinds of moth larvae. Spray it during dry weather on small larvae when the egg hatch is finished and leaf extension 40 to 50 percent complete. Chemical insecticides (see page 50) are also most effective when applied to the small larvae. Don't use these chemicals near water or bee hives; they can be toxic to both fish and bees. Egg and larval parasites, a virus, general insect predators, and birds also help control outbreaks of this pest.



Wingless female laying eggs in frothy mass.

Western Spruce Budworm

Choristoneura occidentalis Freeman

The western spruce budworm is a serious forest pest that also damages ornamental and Christmas trees growing at higher elevations. The budworm attacks Douglas-fir, white fir, and spruce. Outbreaks are periodic and can last from several years to over a decade. Damage from budworm outbreaks includes tree mortality, top-killing, and growth loss. Defoliation in recreation areas is unsightly, and camping and picnicking can be discouraged by large numbers of dispersing larvae.

BIOLOGY: Western spruce budworm moths are about an inch long (22 to 28 mm) and mottled gray to orange-brown in color. Eggs are laid on the undersides of needles throughout the crown of host trees from early July through mid-August. About 50 (range 15 to 120) pale green eggs are laid in two or three rows. Like fish scales, each egg overlaps the preceding one. Hatching usually occurs within 7 to 10 days.

Newly hatched larvae are often dispersed by the wind to other branches. After a few days, they seek overwintering sites under bark or cone scales, between needles, or in other protected spots on the tree. They emerge the next May and chew paths through buds or feed at the base of new needles on expanding shoots. As they feed, they produce a silk webbing that catches uneaten needles. These needle remnants dry, turn red, and make the tree look scorched. The final two larval stages may be 25 to 32mm long and account for most of the defoliation. As new needles become scarce, larvae disperse on silk threads to the understory or adjacent trees.

Pupation occurs from late June to mid-July and lasts about 10 days. Adult moths emerge between late June and early August, depending on locality and weather conditions.

Larvae hatching from egg masses on needles.

CONTROL: At least 40 species of insect parasites attack the budworm; however, when weather and stand conditions are favorable, artificial controls may be necessary to keep budworm populations in check on high value trees. Both chemical and biological insecticides are registered for use against the western spruce budworm. The microbial insecticide *Bacillus thuringiensis (B.t.)* provides an effective alternative to chemical control. *B.t.* is a bacterium that produces a toxin lethal to many kinds of moth larvae. Spray it on small larvae during dry weather. Chemical insecticides (see page 50) are also most effective when applied to early larvae. In forests, reduce budworm potential by thinning stands to remove Douglas-fir and white fir and by heavy regeneration cuts that favor the establishment of pine and aspen. Thinning to reduce stand density will also increase vigor and reduce stress on remaining trees.

Full-grown western spruce budworm larva.

Infested, expanding shoot.

Bagworms

Thyridopteryx ephemeraeformis (Haworth)

Bagworms are common defoliators of ornamental junipers, cypress, and arborvitae in southeastern New Mexico and in the Rio Grande Valley from Albuquerque south to Las Cruces. The insects are also found on other conifers and many hardwood species in urban areas. Bagworms may be expanding their range in New Mexico through the movement of plant materials.

BIOLOGY: Bagworms are caterpillars that construct tough, silk, spindle-shaped bags covered with pieces of foliage to protect themselves from birds and other predators. They crawl with their head and legs exposed and when disturbed, they retreat into the bag.

The female bagworm does not develop wings and can lay over 1,000 eggs within the bag. Eggs hatch in late April or May depending on weather conditions and tiny larvae emerge from the old bags which are firmly attached to twigs and branches. Newly hatched larvae are dispersed in the wind. Young caterpillars construct silk bags that often go unnoticed. As caterpillars grow, they enlarge the bags to a full size of about 2 inches. Bagworms mature in August or September and anchor the bags to branches and pupate. Winged males emerge and mate with wingless females. There is one generation per year.

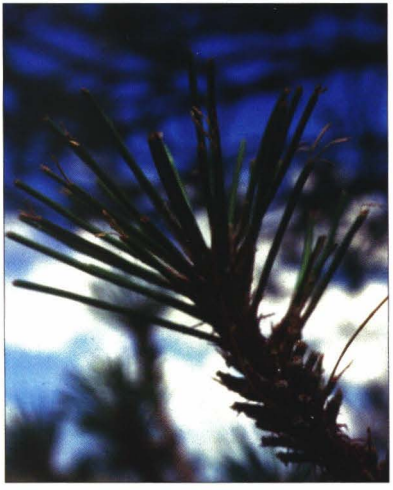
CONTROL: Bagworms are often a problem on isolated trees or in urban settings. Before eggs hatch in late April or May, bags can be picked from the trees and destroyed by drowning them in a bucket of soapy water. After eggs have hatched, the small caterpillars are susceptible to *Bacillus thuringiensis* or spinosad. As the bags get larger, synthetic insecticides will be necessary for control. Often bags are not noticed until defoliation is extensive and feeding is nearly complete. Chemical control at this time is too late.

Spindle-shaped bagworm case.

Conifer Sawflies

Neodiprion spp., *Zadiprion* spp.

Conifer sawflies can be divided into two groups—the "spring" and "summer" sawflies. Spring species generally feed on old needles so the new foliage remains and trees are never completely defoliated. However, summer sawflies feed on new needles first and then attack older needles. Defoliation by summer sawflies results in greater growth loss and more frequent tree mortality.



Typical sawfly feeding damage.

Adult female sawfly and eggs laid in slits on needle.

CONTROL: Since the insects feed in colonies, simply wash the larvae off with a high pressure hose, prune infested branches, or pick the larvae off by hand. For larger outbreaks, you may need to use a registered insecticide (see page 50).

BIOLOGY: Adult sawflies are wasplike insects less than 1/2-inch (11mm) long. The female uses a sawlike ovipositor to cut slits into needles where eggs are laid. Most sawfly larvae feed in groups of 50 or more. Young larvae skeletonize the needles. Older larvae consume needles entirely. Larvae resemble caterpillars but have six or more pairs of abdominal prolegs and one pair of eye spots on the head. There is wide variation in color; many species are dark green or black.

Gregarious sawfly larvae clustered around branch.

Conifer Aphids

Cinara spp., Elatobium abietinum

There are many species of conifer aphids in New Mexico that attack pines, true firs, Douglas-fir, and spruces. Many of these are specific to a particular genus of tree, some even to a particular species. Conifer aphids are rarely a concern in the forest but often an annoying pest on ornamentals around homes. Heavy infestations cause foliage to yellow and stunt the growth of young trees. Needle growth is reduced, twigs dry, and heavy defoliation occurs with excessive feeding. Occasionally, even larger trees are so weakened that they die in a few seasons or are attacked by other insects.

Aphids feed by piercing the bark of branches and twigs and sucking out large amounts of sap. Because they can't use all of the liquid portion of the sap, they expel much water, sugar, and other compounds. This sweet, sticky substance is called honeydew and is often covered with a black fungus called sooty-mold. Ants, bees, and wasps are attracted to the honeydew. When aphid populations are high, honeydew rains down, covering lower branches and objects below the tree. Sometimes it appears as though the tree and adjacent area were sprayed with crude oil.

Aphid eggs on ponderosa pine needle.

Spruce aphid defoliation on Colorado blue spruce.

BIOLOGY: Most species are quite large for aphids, up to a quarter inch (6mm), and are generally dark in color. In the fall, females lay shiny, black eggs that resemble very tiny jelly beans on the twigs and needles. Eggs hatch in the spring and the females soon begin producing live young without mating. There are a number of generations per year with both winged and wingless forms.

CONTROL: Low populations are usually controlled by natural enemies. Damaging densities of aphids should be present before taking any control action. Several chemical pesticides (see page 50) and insecticidal soaps effectively control conifer aphids.

Aphids on spruce branch.

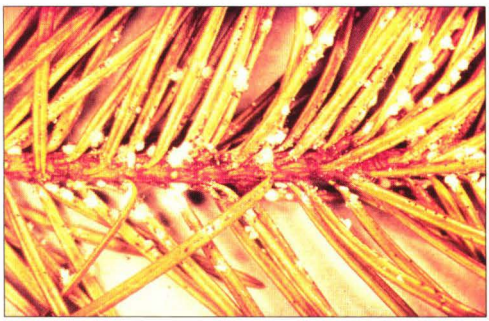
Lady beetles and larva are important aphid predators.

Cooley Spruce Gall Adelgid

Adelges cooleyi (Gillette)

Cooley spruce gall adelgid is the most common gall-forming adelgid on spruce in New Mexico. The galls are cone-shaped or pineapple-shaped. The insect is not usually considered a forest pest, but is often troublesome on ornamental spruce and in Christmas tree plantations where large numbers of galls are aesthetically damaging. Galls don't seriously affect overall tree health.

BIOLOGY: Generally, winged females fly from Douglas-fir to spruce where they lay eggs at the bases of newly expanding buds in early spring. Nymphs hatch from eggs and begin feeding at the bases of growing needles. In response to chemicals injected by feeding nymphs, the tree quickly envelops the insects in rapidly developing galls. Young galls are green to purple and become purplish or reddish brown with age. Galls contain 50 to 350 nymphs and are usually from 1- to 3-inches (25-75mm) long. In mid-July, galls begin to dry and open, allowing the full-grown nymphs to crawl out to the needles. Nymphs molt into winged adults and fly back to Douglas-fir to lay eggs. This generation of nymphs secretes a waxy, woolly covering over their bodies as they feed. The insects look like little balls of cotton clinging to needles. Occasionally, heavy infestations on Douglas-fir will look like snow on the tree. Feeding causes yellow spots on the needles and may cause distorted needles. Eventually, another winged form is produced that migrates back to spruce, completing the life cycle.



Alternate life-stage or "wolly aphid" on Douglas-fir.

Galls on spruce.

CONTROL: There are insecticides (see page 50) to control the adelgid; however, timing of the spray is difficult to determine for effective control. Dormant oils applied before buds swell have effectively controlled the overwintering stages. However, there is a risk of injuring or discoloring foliage when using oils. On small ornamentals, prune off galls before adults emerge. It may also help to plant spruce or Douglas-fir exclusively, rather than planting the species together.

Spider Mites

Oligonychus spp., *Tetranychus* spp.

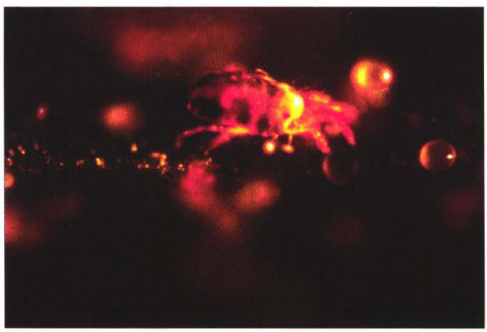
Although these tiny arthropods have six legs when they hatch from the egg, they're not insects. After molting once, they become eight-legged. There are a number of species that may be green, yellow, orange, or red, often with dark pigmented patterns. Spider mites feed on a variety of conifers but are most likely to be a problem on spruce and juniper. Feeding symptoms resemble those of aphids and scales—spotting, yellowing, and premature dropping of needles. Webbing and associated eggs, cast skins, and live mites are also characteristic. The webbing can become obvious if it becomes covered with dust.

BIOLOGY: Spider mites have piercing-sucking mouth parts and damage trees by sucking plant juices from needles. Numerous generations can be completed in a single year and the population can explode in hot, dry conditions in the absence of natural enemies.

The spruce spider mite, *Oligonychus ununguis* (Jacobi), and the two-spotted mite, *Tetranychus urticae* (Koch), appear to be the primary species found in New Mexico.

CONTROL: Wash the plants with a strong stream of water to remove many of the mites and help keep the population in check. For large plantings, there are a number of miticides registered as well as insecticidal soaps, and dormant and summer oils (see page 50).

Comparison of clean (left) and mite infested, dusty foliage.



Closeup of spider mite and eggs.

Pine Tip Moths

Rhyaciona spp., *Dioryctria albovittella*

There are at least eight different species of pine tip moths in New Mexico. All species mine in the buds and terminal shoots. Injury is most severe on trees under 12 feet tall that may be stunted or deformed by heavy infestations. Hosts include ponderosa, piñon, eldarica (Afghanistan), and other pines.

Damage to pine shoot.

BIOLOGY: Most species have one generation per year; the Nantucket pine tip moth has two to four generations. Eggs are laid on new shoots or terminal buds from March through June depending on the species. Newly-hatched larvae feed for a short time at the bases of needles. They then bore into buds, laterals, and terminals, and mine out the pith from the tip down to the base of the shoot. The point of attack is marked by a small resin flow, but no pitch nodule is formed. The larvae are yellow to orange to brown and are 1/2 to 3/4 inch (10 to 20 mm) long when full grown. Tip moths, depending on the species, overwinter as pupae in the tips or shoots, in bark crevices, or in litter below the tree.

CONTROL: Heavily attacked ornamentals may require insecticidal control (see page 50). Timing of control is critical for success. Control the newly hatched larvae before they bore into the shoots. Use pheromone traps to monitor moth populations to determine times of peak egg laying.

The southwestern pine tip moth, which is common in northern New Mexico, can be reduced by destroying the overwintering pupal stage. Pupae of this species are found attached to the root collar of the tree in plasterlike cocoons.

Pinyon tip moths (*Dioryctria albovittella*) generally do not warrant control since tree form is not seriously compromised by their feeding.

Severely damaged ponderosa pine.

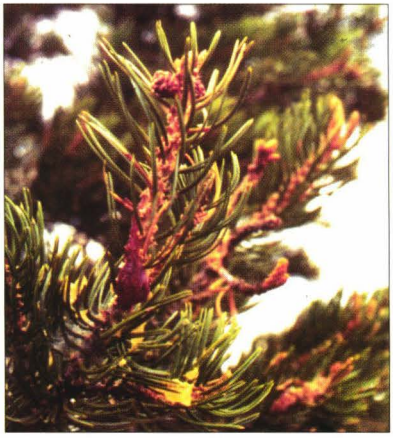
Nantucket pine tip moth adult.

Pinyon Pitch Nodule Moth

Petrova arizonensis (Heinrich)

Pinyon pitch nodule moth attacks piñon pines throughout New Mexico. Attacks are characterized by fading branch tips and nodules of pitch formed at the insect's feeding sites. The pitch nodules are hollow balls of pitch 1/2 to 1 inch (10-25 mm) long, round, smooth, and often light purple or red. They're most often found at the crotch of two or more twigs. The fading twigs eventually lose their needles and fall off. Leaders are occasionally damaged and forked trees may result.

BIOLOGY: The pinyon pitch nodule moth has one generation per year. The small, rusty-brown moths emerge through holes in the pitch nodule in late June and early July. Eggs are laid on needle sheaths of the current year's growth. Newly hatched larvae feed on young needles before boring into the bark at nodes or whorls of twigs or branches. Full-grown larvae are about one-half of an inch (10 mm) long, reddish yellow with a black head and a dark area behind the head. Pupation occurs inside the pitch nodule in June. Pupae move just below the surface of the pitch before they emerge as adults.



Reddish-brown "pitch nodule" and fading needles characterize new attack.

CONTROL: There are no registered insecticides to control this insect. In the forest, top-killing of pinyon is rarely important. On valuable ornamental trees, control the insect by pruning and destroying the infested tips as they fade in May or early June before the adult moths emerge. On branches and stems, destroy larvae by crushing them within the pitch nodule.

Dead tips and crusty pitch nodule with adult exit hole.

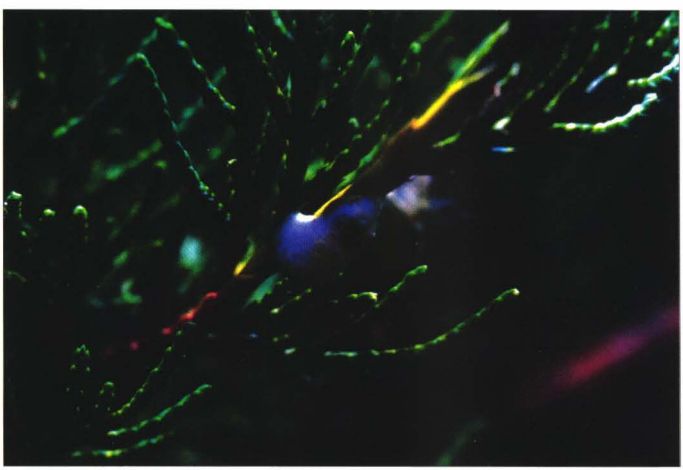
Spittlebugs

Aphrophora spp.
Clastoptera spp.

Spittlebugs feed on many conifer species in New Mexico but those found on juniper are most often noticed. The insects are characterized by spittlelike froth produced by feeding nymphs. The insect's feeding causes no significant damage to forest or ornamental trees. Scattered twig mortality may be seen in the crown of infested trees.

BIOLOGY: Adult spittlebugs (froghoppers) are very active and superficially resemble leafhoppers. Most species lay eggs in midsummer in rows on the foliage. Eggs hatch the following spring. Nymphs of some species drop from the trees and feed on understory shrubs while those of the juniper spittlebug remain on the trees. Nymphs are soft-bodied and white to brown. As they feed, they produce masses of "spittle" by internally blowing air through a viscous sugar solution and releasing froth through the anus. The spittle serves both as a protective device and as a means of reducing evaporation. Nymphs shed their skin five times before molting into winged adults. Adults continue to feed all summer on sap from twigs but do not produce a spittlemass.

CONTROL: Spittlebug injury isn't serious in New Mexico and doesn't warrant control, but spittlemasses on ornamentals can be unsightly. Use a strong stream of water from a garden hose to dislodge nymphs and wash away the spittlemasses.



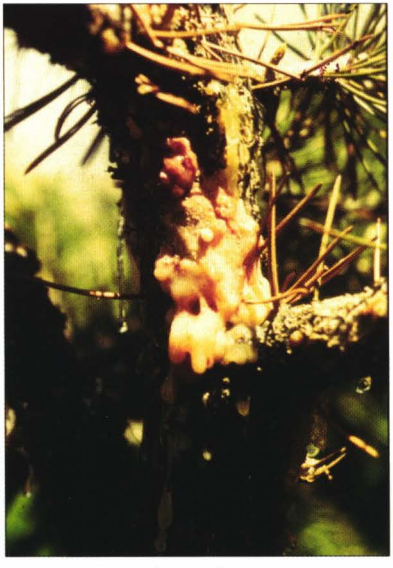
Juniper spittlebug spittle mass.

Bark Moths and Pitch Moths

Dioryctria spp. *and Vespamima* spp.

Bark moths and pitch moths have similar habits and effects on trees. Piñon pine is the primary host in New Mexico, although ponderosa pine and occasionally Douglas-fir and the true firs are attacked. Larger branches, limbs, and trunks of young trees are attacked. Repeated attacks can seriously weaken trees and kill branches. The most severe damage is to trees under 20 feet, especially in urban areas. The insects are rarely a problem on larger trees or in the forest environment. Pitch moth attacks appear as large, ugly masses of pitch that form at the wound site. Bark moth attacks typically produce less pitch.

Pitch moth attack on the underside of piñon branch.



Fresh pitch moth attack on piñon.

BIOLOGY: Pitch moths (*Vespamima* spp.) require 2 years for one generation and overwinter as larvae each winter. Bark moths (*Dioryctria* spp.) require only 1 year for a generation and overwinter as eggs or larvae. Eggs are laid in bark crevices or near mechanical wounds on the bark. Newly hatched larvae tunnel under the bark, forming irregular galleries or elongated gouges in the sapwood. Pitch moth larvae feed on pitch the tree produces in response to their tunneling. Oozing pitch masses 1 to 3 inches (25-75 mm) in diameter cover entry holes and conceal larvae and their destructive tunneling. Full-grown larvae are 3/4 to 1 inch (15-25 mm) long, dirty white, yellow, orange, light green, or light brown. Bark moth larvae feed on the inner bark and when full grown, are marked with rows of dark spots.

CONTROL: No insecticides are registered for use on these insects. The only effective control is removing larvae from the pitch mass or from under the bark with a knife or similar tool. Avoid pruning or mechanical injury to the bark during the summer months when adult moths are seeking egg laying sites.

Bark moth larva mining under ponderosa pine bark.

Twig Beetles

Pityophthorus spp., *Pityogenes* spp., and *Pityotrichus* spp.

Twig beetles are frequent pests of pines and occasionally spruce and other conifers. In forests, they attack shaded-out and storm-damaged twigs and branches. Occasionally, high beetle populations develop in drought-stressed, injured, or recently felled trees. Generally, breeding is restricted to twigs and small branches, but larger branches and thin barked portions of the trunk of stressed trees may be attacked. Recently transplanted pines may be killed by trunk infestations.

Twig beetle damage to piñon tips.

Trees attacked by twig beetles can be identified by fading branches throughout the crown. Tan sawdust is produced around the attack site. On smaller twigs and branches, most of the cambium will have been mined beneath the bark. Small, star-shaped egg galleries can be seen under the bark on larger branches and small trunks.

Tiny exit holes on pine twigs and branches.

BIOLOGY: Adult twig beetles are 1/16 to 1/8 inch (1.5 to 3 mm) long and dark brown. Most species have rounded rear ends but a few have a pair of short spines. The larvae are fat, white, "C"-shaped grubs with light brown heads. Most species have 2 to 4 generations per year, depending on local conditions.

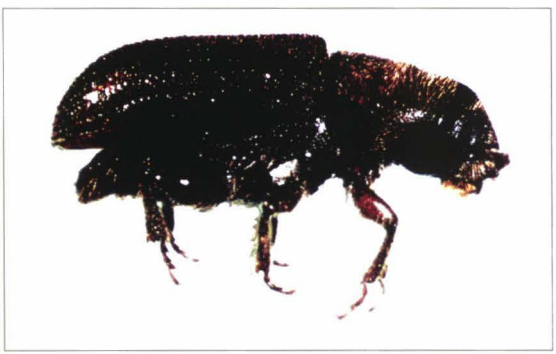
CONTROL: Control infestations of twig beetles by hand pruning infested twigs and branches, and by keeping trees vigorous with supplemental food and water.

Bark Beetles

Ips spp., *Dendroctonus* spp., *Scolytus ventralis*, *Dryococtes confusus*, and *Phloeosinus* spp.

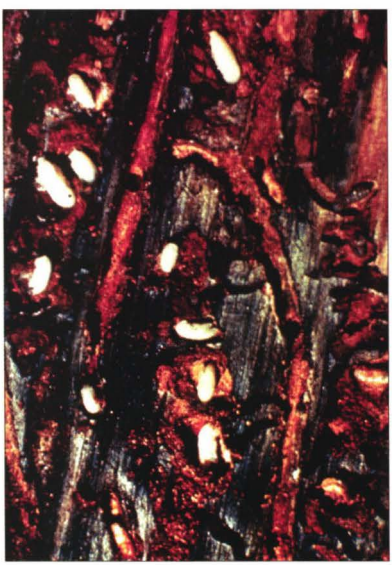
Ips beetles, also called engraver beetles, attack ponderosa and piñon pines as well as other conifers. Dendroctonus beetles attack medium to large ponderosa pine, blue spruce, Engelmann spruce, and Douglas-fir trees. The fir engraver (*Scolytus ventralis*) and the balsam bark beetle (*Dryococtes confusus*) attack

Ips adult (about 3/8 inch long).



Dendroctonus adult.

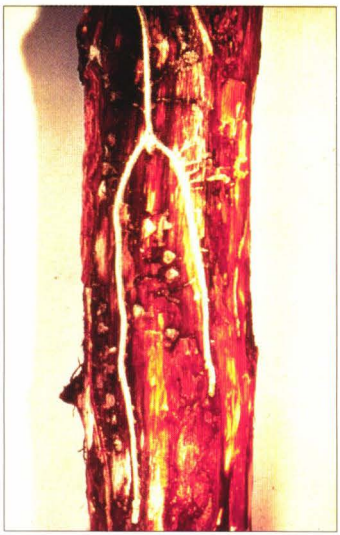
Full-grown bark beetle larvae and pupae. Note blue stain to wood caused by a fungus introduced by the beetles.



true firs. Bark beetles in the genus *Phloeosinus* attack junipers and cypress (Cupressus). Different species within the genera are difficult to distinguish based on body shape alone. Host species attacked, location, and shape of tunnels (egg galleries) they excavate are all important clues in identifying the pest species.

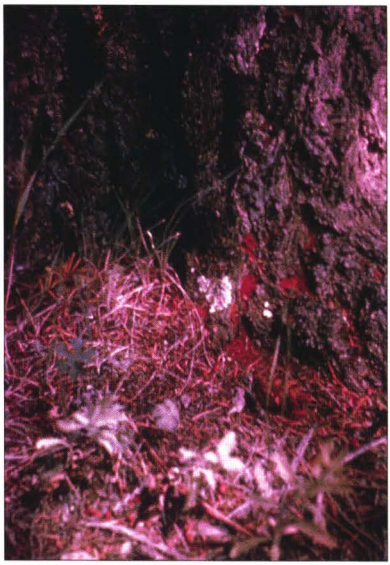
BIOLOGY: Details of the life cycle vary with each species but some generalizations can be made. Initial attack on a tree is made by a few adult beetles. Once a tree is selected, the beetles produce an "aggregation" pheromone, drawing

many beetles to the tree. The attack on the tree may be initiated by the male (i.e.. *Ips* spp.) or by the female (i.e.. *Dendroctonus* spp.) beetle. The beetle chews through the bark and excavates a chamber in the moist tissue beneath the bark. The opposite sex then enters the chamber and mating occurs. The female beetles then excavate distinctive tunnels or egg galleries under the bark. Eggs are laid in niches along the lateral walls.



Ips gallery showing central mating chamber and radiating egg galleries.

Adult beetles may introduce a number of microorganisms to the tree when they attack. Some species have evolved specialized pockets for carrying such microorganisms as fungi, yeasts, and bacteria. Introduced blue-stain fungi are particularly important in killing the tree and may provide nutrition for the developing brood.



Boring dust at the base of a tree.

Pitch tubes from Dendroctonus beetles on ponderosa pine.

After hatching, larvae bore away from the egg gallery at right angles. They molt three or four times and then construct a pupal cell either in the phloem or in the bark.

Fading crowns of bark beetle infested trees.

Bark beetles usually attack severely weakened or damaged mature or overmature trees. Trees damaged by lightning or harsh weather and trees stressed from transplanting, logging slash, and recently cut firewood are prime candidates for bark beetle colonization. Vigorously growing trees have active resin systems that deter such colonization. When the beetle bores into a healthy tree, resin exudes through the wound and may prevent the beetle's entry. The resin may also inhibit spread of the fungus that aids the beetles in killing the tree. When populations of bark beetles are very high, particularly around an outbreak, trees may be attacked by so many beetles that even healthy trees succumb.

Time between generations varies considerably for different species of bark beetles mainly due to differences in temperatures. Some species of *Ips* can complete their life cycle in 6 to 8 weeks during warm summer months. Others require 2 years for a single generation, such as the spruce beetle (*Dendroctonus rufipennis* Kirby), which lives at high elevations. Most species will have one or two generations per year.

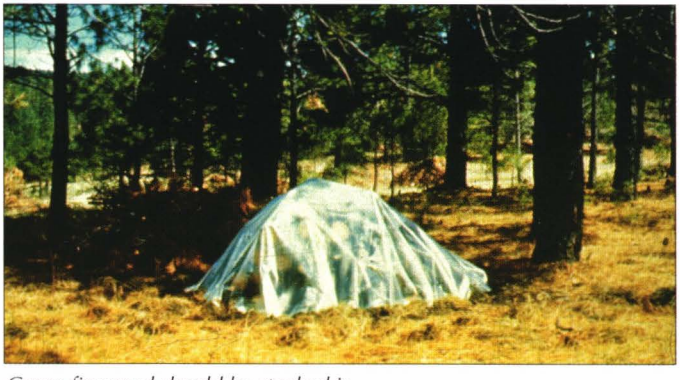
SYMPTOMS: Foliage high in the tree begins to fade, turning from green to yellow or red after the tree has been attacked. Boring dust, a sawdust-like material pushed out of beetle galleries, can often be found around the base of the tree, in bark crevices beneath entrance holes, and on tops of branches where they intersect the trunk. Globules of resin called "pitch tubes," produced as the tree's defense, may or may not be present. Woodpecker activity on the trunk is also a good indication that the tree has been attacked.

PREVENTION AND CONTROL: Once a tree has been successfully colonized by bark beetles, it cannot be saved. Infested trees should be removed, burned, or buried as soon as possible to protect surrounding trees from attack by emerging beetles.

Check green firewood for bark beetles. Bark beetles emerging from infested firewood account for many tree losses near homes and in urban settings. If firewood has been stored for at least one season, the beetles won't be present. Green firewood collected or purchased in summer when temperatures are high should be stacked in direct sunlight and covered with clear plastic. Don't use black or other opaque plastic because it prevents sunlight from entering. Piles should be no larger than 4x4x4 feet or 1/2 cord. The edges of the plastic should be buried in the ground. This creates a greenhouse effect, raising temperatures under the plastic up to 160 degrees (F). After 2 or 3 weeks of sunny weather, the beetles should all be dead. Bark beetles can also be prevented or controlled in firewood by peeling off the bark. This exposes the phloem, rendering it useless to the beetles. The method is difficult but effective.

Green firewood piles are often bark beetle breeding grounds.

Preventive control measures using chemicals are discussed on page 51.



Green firewood should be stacked in the sun and covered with clear plastic.

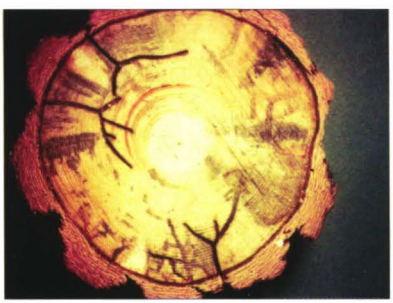
Roundheaded and Flatheaded Wood Borers

Family Cerambycidae
Family Buprestidae

Roundheaded and flatheaded wood borers attack recently dead and dying trees, often riddling them with tunnels. In the forest, they become especially numerous after fires. Roundheaded borers are often the most destructive, tunneling deep into the wood. Fresh-cut logs left in the forest or in storage for a year can be seriously damaged. These beetle larvae can often be heard chewing in infested firewood or vigas. Adults feed on cambium of twigs and small branches and on needle bases. Shoot tips occasionally flag above adult feeding sites. Adult feeding damage can be heavy along edges of recent clearcuts, in groups of seed trees left in clearcuts, or in residual blocks of timber left in harvested areas.

Adult roundheaded borer, a long-horned beetle.

BIOLOGY: Generally, the life cycle is complete in at least 2 years. Eggs are laid in slits in the bark throughout the summer. Young larvae feed on wood beneath the bark, creating tunnels filled with frass and wood chips. In late summer, they tunnel deeper into the wood and overwinter. The next year they continue tunneling through the wood. Full grown roundheaded larvae are legless, with cylindrical, segmented bodies. Flatheaded larvae are similar but are broad and flat behind the head. They pupate at the end of a tunnel beneath the bark. Adults emerge through circular (roundheaded wood borers) or oval (flatheaded and some roundheaded wood borers) holes cut in the bark and feed on needles and tender bark of twigs.



Cross-section of borer infested log.

CONTROL: Wood borer damage to logs cut for lumber or vigas can be prevented by using wood soon after cutting it. Other guidelines for preventing damage are as follows:

- Before spring, remove wood cut in the winter from the stand.
- When storing wood in the forest, piles should be as large as practical and a long distance from cutting areas.
- Wood cut in summer should be used immediately.
- Wood stored in the forest in summer should not be stored in the mill woodyard.
- Wood piles in the woodyard should be as large as possible.

Juniper Borers

Callidium spp., *Atimia* spp., *Trachykele blondeli, Chrysobothris* spp. *and Styloxus bicolor*

Several roundheaded and flatheaded wood borers are aggressive pests in drought-stressed junipers and cypress in New Mexico. Damage can be extensive before symptoms are apparent. Usually a large portion of the tree or the entire tree dies before the insects' exit holes are noticed.

BIOLOGY: *Callidium* spp. larvae bore beneath the bark making very wide, wavy tracks that distinctively score the outer sapwood much like a router. Older larvae excavate oval tunnels deep in the wood and spend the winter. Adults can emerge throughout the warm months of the year. There is one generation per year. Adult beetles are rather short-horned for cerambycids and dark blue or black. These roundheaded borers leave an oval or rectangular exit hole. *Atimia* spp. are small roundheaded borers about one-quarter inch (6.5-8.5 mm) long and generally have a 1-year life cycle. These long horned beetles attack the thin barked portions of seriously weakened and dead juniper and cypress. *Trachykele blondeli*, the western cedar borer, is 1/4 to 3/4 inch (11-17 mm) long and attacks juniper and Arizona cypress in New Mexico. Females lay eggs under bark scales on branches of living trees. Flatheaded larvae bore from branches into the main bole. They feed primarily in the heartwood for several years. Adults emerge in the spring leaving oval or rectangular exit holes.

Juniper borer adult exit holes.

Cross-section of damage caused by Juniper borers.

Chrysobothris spp. are flatheaded borers in junipers and Arizona cypress. They are medium sized beetles about one-half inch (11.5 mm) long. Larvae bore into the bark and outer wood of weakened trees.

The juniper twig pruner, *styloxus bicolor*, is a small roundheaded borer that mines small branches and can cause twig dieback during dry periods.

CONTROL: No practical controls or preventive measures have been developed for this insect.

Callidium *species adult.*

Juniper twig pruner damage.

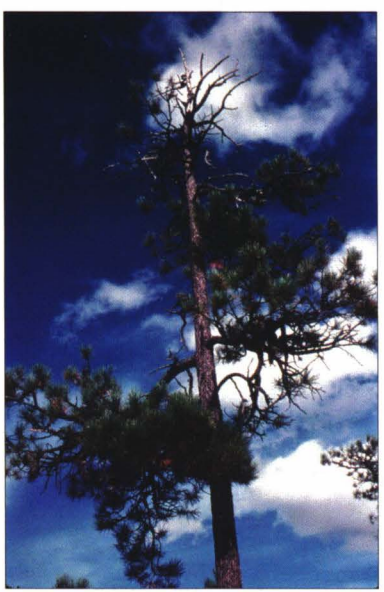
Mistletoes

Arceuthobium spp. *and Phoradendron* spp.

Mistletoes are parasitic flowering plants that weaken and eventually kill their host trees by stealing water and nutrients. Because of their widespread distribution and persistent nature, mistletoes are easily among the most damaging conifer pests in New Mexico. At the same time, mistletoes are native plants that have ecological roles in our forests and woodlands. Several different species of mistletoe occur in the State, each of which occurs mostly on a particular type of tree.

Dwarf mistletoes (*Arceuthobium* spp.) are typically yellow, brown, or olive in color, leafless and usually no more than a few inches in length. Three species—those infecting ponderosa pine, pinyon pine, and Douglas-fir—occur throughout most of the ranges of their respective hosts. Dwarf mistletoes attacking spruces and white pine are found in parts of southern New Mexico. Chihuahua pine dwarf mistletoe occurs with its host tree in extreme southwest New Mexico.

True mistletoes (*Phoradendron* spp.) are green, usually leafy, and often a foot or more in length. Juniper mistletoe (*Phoradendron juniperinum*) is common on junipers throughout the State, and it is often mistaken for dwarf mistletoe because this species is leafless. Two other (leafy) species also infect junipers in parts of southern New Mexico, but these are relatively rare. Other true mistletoes, commonly known as Christmas mistletoes, infect hardwoods, especially oaks and cottonwood.



Witches brooms caused by dwarf mistletoe.

BIOLOGY: Mistletoes have separate male and female plants. Seeds are produced in small berries on the female plants (see cover photo). Dwarf mistletoes have explosive berries that spread the seed, usually for horizontal distances of 10 to 15 feet, but occasionally up to 40 feet. True mistletoes are spread by birds, which eat the berries and pass the seeds unharmed in their droppings. Seeds of both types of mistletoe are sticky and adhere to host foliage. After germination, a root system develops in the branch. Visible shoots first appear 3 to 5 years (or longer) after initial infection.

Dwarf mistletoe infection can occur on all ages and sizes of trees. Spread occurs both from tree to tree and within the crowns of individual trees. Plants tend to build up initially in the

lower part of the crown and gradually spread upward. Although dwarf mistletoe infections develop and spread slowly, trees that become infected at a young age usually die before reaching maturity. Medium to large trees with light infection can survive and even remain vigorous for many years. Infection eventually slows and distorts the normal growth of the tree, often resulting in the characteristic "witches' brooms." Extensive dwarf mistletoe infestation can increase forest flammability.

True mistletoes usually infect larger, older trees, where birds prefer to perch. Because they are green and manufacture much of their own food, these plants are generally not as damaging as dwarf mistletoes, although heavily infected trees can be killed, especially during periods of drought.

CONTROL: Mistletoes can be difficult to control, especially in areas with extensive infestation. On trees with light infection, mistletoe-infested branches can be pruned to remove the infection and reduce the spread of the parasite. Pruning is only effective if the mistletoe is at least 6 inches from the trunk. Dwarf mistletoes can often be controlled, at least temporarily, in tree thinnings that improve the overall health and vigor of the forest. Within infested portions of a stand, the best strategy is to reduce infection as much as possible without sacrificing the best trees. More aggressive tree removal strategies can be used successfully in some situations as part of a long-term forest management strategy. Nonhost trees can be favored in some infested stands. Prescribed burning has recently been demonstrated to have a controlling effect on dwarf mistletoe.

Male dwarf mistletoe plants on ponderosa pine.

True mistletoe on juniper.

White Pine Blister Rust

Cronartium ribicola

White pine blister rust is a very destructive, nonnative fungal disease that was introduced to North America on infected nursery stock around 1900. It was first found in New Mexico in 1990, on native Southwestern white pine near the village of Cloudcroft. It has since been detected throughout the Sacramento and adjoining White Mountains of southern New Mexico, an area that contains the largest population of white pines in the State. The disease has been found more recently in the Capitan Mountains and on Gallinas Peak, which are isolated mountains north of the main outbreak area.

Since its introduction to North American, blister rust has done extensive damage to several species of white pine in the Pacific Northwest, the northern Rockies, the Lake States, and the Northeast. Southwestern white pine is also proving to be very susceptible to the disease, especially on cool, moist, high elevation sites. In some stands, over 90 percent of the white pines are already infected. Over time, blister rust will kill a large proportion of the white pines within the present outbreak areas, and the disease will likely spread to other parts of the State. Limber pine and bristlecone pine, which occur in forests in northern New Mexico, are known to be susceptible.

BIOLOGY: Like most other rust diseases, the blister rust fungus requires two unrelated host plants to complete its life cycle: a white pine and a currant or gooseberry bush (genus *Ribes*). Spores produced on the underside of *Ribes* leaves in the late summer infect pines. From a pine needle, the fungus grows into the inner bark, forming a swollen canker that encircles the branch. A few years after infection, the end of the branch dies, resulting in characteristic branch "flagging." The fungus continues growing toward the main trunk, which it eventually girdles, killing the top of the tree. After this, the fungus works its way down the trunk, eventually killing the rest of the tree. Young trees can be killed within a few years, while large infected trees may survive for decades.

An infected white pine may contain numerous cankers, each originating from spores produced on *Ribes*. The characteristic "blisters" erupt through the bark of the cankers each spring, beginning about 3 years after initial infection. Spores produced in the blisters infect *Ribes*, and these spores can blow long distances, spreading the disease to new areas.

CONTROL: Branch pruning can remove cankers that are at least 6 inches from the main trunk, prolonging the life of some infected trees. No fungicides have proven effective for controlling blister rust. *Ribes* eradication in and around stands of white pine was a common forestry practice throughout the mid-1900s, but this practice has been largely discontinued.

Since the 1970s, most efforts at controlling this disease in other parts of the country have focused on use of genetic resistance. Using the low levels of resistance that occur

naturally, resistant planting stock has been developed for western white pine in the northern Rockies and sugar pine in California. Initial testing of Southwestern white pine seed from the Cloudcroft area indicates that a very small proportion of the population is resistant to blister rust. This natural resistance should help insure survival of the species, and might eventually be used by managers to help propagate this native white pine.

To help avoid spread of this disease, white pines and *Ribes* from the Sacramento Mountains and other outbreak areas in southern New Mexico should not be transplanted elsewhere in the State.

Stem canker with blisters.

Spores on Ribes.

Juniper Rusts

Gymnosporangium spp.

Several species of stem rusts occur in New Mexico on junipers. All produce orange to brown fruiting structures or spore sacs that gelatinize during spring rains. Swellings, distortions, and witches brooms often occur on junipers, but alternate host plants can be more seriously affected by these fungi. *G. bethelii* causes knobby galls or tapered swellings, and the alternate host are hawthorns (*Crataegus* spp.). *G. nelsonii* causes globe-shaped galls on juniper and has alternate host species in the genus *Amelanchier* or service-berry. *G. speciosum* causes tapered swellings on woody tissue and is the showiest of the various species due to the red-orange structures. Its alternate hosts include plants in the genera *Fendlera* and *Philadelphus*. *G. bermudianum* does not require an alternate host and *G. multiporum* probably does not require more than one host. An eastern species, the cedar-apple rust, *G. juniperi-virginiana*, has been found in the Albuquerque area. This rust can cause significant damage to apple trees.

BIOLOGY: Most *Gymnosporangium* rusts require two hosts to complete their life cycle. The gelatinous structures are produced following spring or summer rains and they produce spores that infect the alternate host. Yellow to orange lesions occur on the alternate host and they produce another type of spore that are dispersed by the wind to junipers where infection causes galls or swellings. The fungus overwinters on junipers.

CONTROL: Other than branch dieback, the native species of *Gymnosporangium* in New Mexico cause little damage to junipers and their alternate hosts and control is usually unwarranted. However, fungicides have shown to be effective against the cedar-apple rust to protect apple crops.

Gelatinous fruiting structure.

Broom Rusts

Chrysomyxa arctostaphyli
Melampsorella caryophyllacearum

Broom rusts are primarily a forest problem. Infections cause growth loss, top kill, and occasionally tree mortality. Trunk infections may provide entrance for decay fungi.

Two species of broom rust occur in New Mexico—spruce broom rust (*Chrysomyxa*), which attacks Engelmann spruce and blue spruce, and fir broom rust (*Melampsorella*), which attacks white fir and subalpine fir. Infections are characterized by conspicuous, dense masses of branches called witches' brooms. Witches' brooms are large and yellow, and are usually more dense than those caused by Dwarf Mistletoe.

BIOLOGY: Broom rust fungi require the presence of an alternate host to complete their life cycle and successfully spread. Kinnikinnick is the alternate host for spruce broom rust and chickweed the alternate host for fir broom rust. Needles on brooms are stunted and drop off each fall. Yellow-orange spores produced on the needles infect the alternate host.

CONTROL: On trees with only a few branch infections, witches' brooms can be pruned out if the infection is not too close to the trunk of the tree. Trunk infections are characterized by trunk swelling and cracks in the bark at infection sites. There are no chemical or biological controls available for broom rust.

Broom rust on white fir.

Branch and Shoot Dieback on Spruce

Cytospora Canker
Cytospora kunzei Sacc.

Sirococcus Shoot Blight
Sirococcus strobilinus

Cytospora canker and Sirococcus shoot blight are fungal diseases that mostly affect blue spruce, although other ornamental spruce and Douglas-fir may also be attacked.

Cytospora canker causes death of lower branches followed by progressive dieback up the tree. Trees are occasionally killed, but more often damaged by loss of symmetry. Cytospora cankers are inconspicuous and may or may not cause bark deformation. Any part of the branch is susceptible to girdling except for very small twigs. Typically infected areas are marked by a heavy, clear amber pitch flow that later dries and covers the cankered area with a hard, crusty, white pitch coat. Pitch exuded will also drip down and cover branches below the infection. Needles on infected branches fade and eventually turn brown. Needles may stay on the branch for up to a year after infection.

Sirococcus shoot blight is indicated by fading, drying needles at the ends of branches. Needles eventually drop, leaving the last 2 to 12 inches of branches bare by summer's end. It is usually seen after heavy rainfall and high humidity.

BIOLOGY: Tiny black fruiting bodies of Cytospora canker can be seen by scraping away bark in the transition area of diseased and healthy tissue. Spores ooze from fruiting bodies in wet spring and summer weather and spread to the same or other trees by splashing rain, wind, insects, birds, and man. Spores must land on freshly wounded wood to infect the tree.

Small fruiting structures of Sirococcus shoot blight can be seen with a hand lens on bud scales and other parts of dying shoots. A canker also forms as the fungus grows within the succulent stem; it rarely invades older wood. Spores are produced by fruiting structures during wet periods and are spread by splashing rain and irrigation water.

CONTROL: Trees under environmental stress, especially drought, appear most susceptible to infection. Fertilizing and watering during dry periods aids tree vigor, but will probably not control the disease.

***Cytospora*—**Early detection and removal of infected branches can reduce continued development of the disease. Prune infected branches

close to the trunk. Cankers will continue to produce spores even after pruning so promptly destroy (burn or bury) cut branches. Prune only in dry weather to avoid spreading spores to healthy branches. After pruning, watch for development of new cankers. No chemical sprays adequately control Cytospora on spruce.

Sirococcus—Remove diseased shoots to reduce sources of infection and improve the tree's appearance. Fungicide sprays may help reduce infection if applied before summer rains and periods of high humidity.

Root Diseases

Armillaria spp., Heterobasidion annosum, and Phaeolus schweinitzii

Several root diseases occur in New Mexico forests, the most common being Armillaria root disease (*Armillaria* spp.), Annosus root disease (*Heterobasidion annosum*), and Schweinitzii root rot (*Phaeolus schweinitzii*). These root diseases are native fungi that can function as parasites (causing disease of living trees) and also as saprophytes (decaying and recycling dead woody material). Both Armillaria and Annosus attack a wide variety of conifers and affect all ages and sizes of trees. Schweinitzii primarily affects older trees and is very common in Douglas-fir, although it occasionally infects other conifers, like ponderosa pine.

Root diseases can reduce tree growth, directly kill trees, or predispose them to bark beetle attack or windthrow. In forest situations, root diseases often occur as expanding pockets of tree mortality, but in some areas they remain widely scattered, primarily affecting weak and suppressed trees. For reasons not fully understood, some sites are much more prone to root disease problems than others.

Root diseases can be difficult to diagnose since above ground symptoms often resemble those caused by other agents. The crowns of seedling and saplings killed by root disease usually fade all at once, while a gradual pattern of dieback and crown thinning may occur with older trees. Some infected trees display no outward signs of disease, but may nevertheless be susceptible to windthrow. In ornamental situations, root problems often develop in response to unfavorable soil conditions, such as compaction or abnormally high or low moisture content.

BIOLOGY: Spread of root disease occurs both by means of airborne spores, and underground via root to root contact. In addition, Armillaria produces stringy black structures called rhizomorphs that grow through the soil and can penetrate healthy roots. Because of these special structures, one common name for Armillaria is "shoestring root rot." Another very distinctive feature of Armillaria is a white, striated, latex-like sheet known as a "mycelial fan." These fans grow directly under the

Brown cubicle decay caused by Schweinitzii root rot.

bark on infected roots and can often be found at the root collar of dying or recently killed trees.

Fruiting bodies of these fungi are distinctive and, if found, can provide a reliable means of diagnosing these diseases. The Armillaria fungus, also known as the "honey mushroom," produces clusters of light brown mushrooms in the late summer and fall, often at the base of infected trees or stumps. Annosus produces firm perennial "conks" which vary in size from small buff-colored pustules (often called "popcorn conks") to mature fruiting bodies several inches wide. These grow below ground on the surface of infected roots, or at the base of the tree just below the duff. Annosus conks often can be found within hollows of old stumps. Schweinitzii, commonly known as the "velvet-top" fungus, produces large, flat, circular fruiting bodies, usually found on the ground. These are yellow to orange and quite velvety when fresh, but become brown and crumbly with age.

Armillaria and Annosus cause very similar white pocket rots of infected wood. One difference is that Annosus decay tends to be laminated, that is, the deteriorating wood comes apart at the annual rings. Advanced decay from both of these diseases becomes stringy and eventually spongy. Schweinitzii causes a brown cubicle decay that becomes crumbly in its advanced stage.

CONTROL: Control of root disease can be difficult because these fungi can persist in the soil for decades. Stumps, especially large ones, can provide a "food base" for root disease fungi, increasing the incidence of root disease on some sites. Proper planting techniques, both in forest plantations and for landscape ornamentals, can reduce the likelihood of root disease and other root problems. Use of site-compatible planting stock in forest plantations reduces the chances for root disease and other pest problems.

Needle Diseases

In New Mexico, relatively dry conditions help limit the incidence of foliage diseases in conifers. Many non-insect foliage problems are due to environmental factors rather than disease. However, there are a few needle diseases that may occur.

Lophodermella spp.—This fungus is an occasional problem on ponderosa pine in New Mexico. During outbreaks, nearly all of the second-year foliage in the lower half of the crown may be lost. If conditions allow for successive years of infection, only the current year's needles will be left on the tree. Airborne spores of the fungus settle and germinate on developing needles in spring. The following spring, infected needles turn reddish brown and small, fruiting structures develop that are difficult to detect. Needles dry and fall from the tree shortly after the fruiting structures mature.

Elytroderma deformans—Elytroderma needle cast affects pinyon and ponderosa pine in New Mexico. It can be damaging because it invades twigs and branches and persists for several years. Symptoms occur in spring when all of the year-old needles on an infected twig simultaneously turn red brown 6 to 12 mm from the needle bases. Infected needles persist on the tree until fall or winter. Fortunately, incidence of the disease is low because weather conditions favoring its development are rare. Local outbreaks generally start in sheltered humid places, such as bottoms of deep arroyos, sapling thickets, and on low branches on north sides of trees pole-sized and larger.

Dothistroma pini—Dothistroma needle cast (red band disease or red banded needle blight) may infect ponderosa, pinyon, and Austrian pines in New Mexico. Symptoms first appear as yellow or tan bands around the needles. Bands later turn red. Both old and new needles may be infected, but infection periods differ. Old needles are infected in spring and usually turn brown by fall. New needles are infected in midsummer and turn brown in late summer the following year. Initial infection occurs on the lower portion of the tree and progresses upward. Spores are released during rainy weather and spread by splashing rain.

Rhabdocline pseudotsugae—Rhabdocline needle cast on Douglas-fir is an occasional problem in New Mexico. The most recent outbreak was seen in 1989 in and around the Lincoln National Forest and on Mescalero Apache lands. This conspicuous fungus disease causes mottling and premature shedding of needles. Infection occurs during long, rainy periods while new needles are growing. The disease is not usually serious since conditions favoring infection rarely occur over successive years.

Other Problems

Numerous environmental stresses, both natural and human-caused, may injure or kill trees. Any factor interfering with the tree's physiology can injure it.

Natural Environmental Stresses

Cold Injury—Injury from cold temperatures can usually be categorized as frost damage or winter damage. Frost damage most often occurs in the spring after shoots have begun to grow. Trees most frequently injured are those growing at the northern limit of their species range. Young conifers are more susceptible to injury than are older trees. Frost damage to spring shoots may resemble damage from shoot borers such as pine tip moth. Winter injury generally occurs in midwinter to early spring. Most often, the entire tree above the snow line is affected. Cold winds dry the foliage but because the ground is frozen, the tree can't replace lost moisture so foliage dies and turns red. Protect ornamental conifers by covering them or buffering them from dry, cold winds.

Heat Injury—Tree tissues may be injured by unusually high temperatures. Sunscald results from overheating and drying of bark and is characterized by reddening bark, followed by canker formation. Leaf scorch or needle scorch, a heat injury found more frequently on hardwoods but also on young conifers, results when a tree loses more water through transpiration than it can absorb through the roots.

Water Injury—Lack of water can cause foliage to dry from the tips back and eventually foliage and twigs may die. Drought injury is indicated when foliage yellows or browns and needles are prematurely cast. Flooding or a dramatic increase in the water table can suffocate tree roots, resulting in above-ground symptoms of discolored foliage and spongy bark.

Soil Deficiencies—A shortage of available nutrients can injure or kill conifers. New Mexico soils are often deficient in iron and zinc and have a pH level that ties up many nutrients in compounds the tree can't use. Nutrient abnormalities are indicated by foliage discoloration and often by distorted needles and twigs. Heavy clays commonly encountered in New Mexico are difficult for roots to penetrate and can significantly limit tree growth.

Storm Injury—High winds can break branches, limbs, or trunks. Shallow rooted trees are often uprooted. Heavy snows may break limbs. Hailstorms can wound or kill buds, foliage, twigs, and branches. Damage varies with time of year, size of hailstones, and intensity of the storm. Younger stems with tender bark and trees with developing foliage are most seriously damaged.

Animal Injury—Mice and other small rodents seriously damage trees by feeding on bark at the root collar of young conifers, particularly in plantations. Damage usually occurs in winter when snows are deep, food scarce, and where there is plenty of grass or weed cover around the trees' base. Trees are often completely girdled although symptoms of injury may not appear until the following summer or fall. Sapsuckers also commonly injure and kill trees. These birds drill holes, often in a characteristic pattern, and drink the sap. Bark in heavily drilled areas may die. Occasionally, the tree or its top is completely girdled. Forest trees may be browsed on by deer and damaged by deer or elk rubbing antlers against tender bark. Small ornamental trees and shrubs around the home may be injured by dog urine and by cats sharpening their claws on thin bark.

Human-Caused Stresses

Soil Compaction—Soil trampled by confined animals or compacted by machine traffic is less aerated and resists water penetration and drainage. Injury to tree roots during soil compaction results in yellowing foliage, premature leaf drop, and often death of the tree.

Mechanical Injury—Frequent wounding of ornamental trees occurs from lawn mowers and trimmers hitting the base of the tree. Mechanical injuries can occur from anything scraping against the bark. Poor pruning jobs can seriously wound trees. Excavation around trees can hurt the root system.

Air Pollution—Trees can be injured or even killed by air pollutants. Symptoms of air pollution injury generally include discolored, spotted, or blotched foliage. Most damaging pollutants are produced from industrial emissions and vehicle exhausts. Oxidants produced by internal combustion engines are concentrated in urban areas but may be windborne to rural areas. Ozone injury may occur anywhere from ozone created by lightning. Industrial emissions such as sulfur dioxide and fluorides, usually only cause injury in areas immediately downwind of the pollution generator.

Salt Injury—Deicing salt applied to roads, walks, and driveways can seriously injure trees. Most of the damage occurs on foliage but eventually roots may be killed. Salt-injured trees may have yellow, red, or brown needles. Frequently, only the road side of the tree shows symptoms resulting from salt spray from passing vehicles. Calcium-based salts are less damaging than sodium salts; unfortunately these are infrequently used. Salt-injured trees also appear more susceptible to winter injury.

Herbicide Injury—Conifers are very susceptible to herbicides and herbicide drift. The concentration and type of herbicide reaching the tree, the type of tree, and weather conditions all affect severity of injury. Frequently, foliage and twigs will be distorted. Ornamental trees can be damaged by over application of lawn weed killers, which usually contain 2,4-D.

General Pesticide Recommendations and Precautions

Mechanical and biological options have been provided for reducing pest damage wherever possible. The use of insecticides is rarely necessary in forests where individual tree injury or loss is often insignificant. However, it may be necessary to use pesticides to protect valuable ornamental trees, nursery stock, or forest trees in areas heavily traveled. The nature of pesticides mandates strict adherence to recommended dosages and precautions for handling and use as listed on the label. Follow these precautions whenever using pesticides:

1. Read the entire label before using product.
2. Observe all precautions each time you use a material.
3. Store pesticides under lock and key, out of the reach of children and pets, and away from food and feed.
4. Keep pesticides in their original containers.
5. Dispose of unused pesticides and containers in such a way that they are no longer hazardous.
6. Follow directions pertaining to residual tolerances on edible plants; allow the specified time interval between last application and harvest.
7. Use pesticides only on plants specified and at the correct rate and schedule.
8. Do not eat or smoke while applying pesticides.
9. Wear protective clothing and masks when directed on the label.
10. Bathe and change to clean clothing immediately after spraying or dusting. Wash clothing before reuse.
11. If pesticides are spilled on the skin or clothing, change clothing immediately and wash thoroughly.
12. If illness develops during or after spraying or dusting, call a physician immediately or take the patient to a hospital.
13. Avoid pesticide injury to plants; use separate equipment for herbicides and insecticides.
14. Rates of application have been carefully computed; don't use more than recommended.
15. Don't spray or dust on a windy day; avoid drift that would injure plants on adjacent property.

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers—out of reach of children and pets—and away from foodstuffs.

Apply pesticides selectively and carefully. Do not apply a pesticide when there is danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide it is advisable that you be fully clothed.

After handling a pesticide, do not eat, drink or smoke until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If the pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Dispose of empty pesticide containers by wrapping them in several layers of newspaper and placing them in your trash can.

It is difficult to remove all traces of an herbicide (weed killer) from equipment. Therefore, to prevent injury to desirable plants do not use the same equipment for insecticides and fungicides that you use for an herbicide.

NOTE: Registrations of pesticides are under constant review by the Federal Environmental Protection Agency. Use only pesticides that bear the EPA registration number and carry directions for home and garden use.

Generalized Pesticide Control Strategies for Conifer Pests in New Mexico

Scales—Spray trees with "dormant" or "superior" oil before buds break to kill overwintering immature scales. Don't use dormant oils after buds begin expanding. **Improper use of oils can injure foliage.** Dormant oils can remove the waxy bloom on blue spruce, resulting in discolored foliage.

Insecticide sprays are only effective against the "crawler" stage of scale insects. Repeat applications are usually required at 7- to 10-day intervals to maintain coverage as eggs hatch. Insecticides with labeling for scale insects include acephate (Orthene®), dimethoate (Cygon®), carbaryl (Sevin®), and malathion.

Needle Miners and Gall Formers—Under most circumstances, these pests should not be controlled. Damage can be unsightly but the tree is rarely injured seriously.

Insecticides capable of penetrating the foliage are most useful when needed. Acephate (Orthene) is recommended for needle miners and is effective against pinyon spindle gall midge but labeling for this purpose is limited. Carbaryl (Sevin) may be used against Cooley Spruce gall adelgid in spring when buds expand.

Caterpillar and Sawfly Defoliators—Carbaryl (Sevin) and acephate (Orthene) will eliminate most caterpillar and sawfly problems. *Bacillus thuringiensis* (Dipel®, Thuricide®, etc.), a microbial insecticide is very safe to the environment, is effective on most caterpillars if applied properly. Insecticidal soaps are effective on young sawfly larvae if applied soon after eggs hatch.

Conifer Aphids—It's usually unnecessary to control aphids on conifers. If control is desired, spray trees with a dormant oil before buds break. (See "scales.") Insecticidal soap, acephate (Orthene), dimethoate (Cygon), and malathion will adequately control aphids.

Spider Mites—Miticides such as dicofol (Kelthane®) and dienochlor (Pentac®) are effective against spider mites. Insecticides with some mite activity include acephate (Orthene) and malathion. Insecticidal soaps and horticultural oils are effective early in the season before populations are very high.

Pine Tip Moths—Insecticide sprays for pine tip moths need to cover the branch tips at the time of egg laying and egg hatching. Pheromone traps are available to determine mating and egg-laying periods for most species. Insecticides available for controlling pine tip moth include acephate (Orthene), dimethoate (Cygon), *Bacillus thuringiensis* (Dipel, Thuricide, etc.), and Carbaryl (Sevin). Several restricted use synthetic pyrethroids also are effective for pine tip moths, but can only be applied by a licensed applicator.

Bark Beetles—Once bark beetles have invaded a tree, it cannot be saved. Trees at high risk can be protected from attack by spraying the trunk and large branches with a 2 percent carbaryl (Sevin) suspension or a 0.4 percent solution of permethrin (Astro®). Both insecticides will kill the adult beetles as they chew through bark to enter the tree and pines can be protected for up to a year.

Borers—Insecticide treatments are ineffective against borers once they hatch and burrow under bark. Conifers infested with borers are usually dead or dying from other causes.

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